CLAIMS

1.   A k-th order component generating circuit, characterized by comprising:

5   a plurality i (i is an integer of 5 or more) of differential amplifiers for having a common linear input signal inputted to one input terminal, having a constant level signal of a predetermined level inputted to the other input terminal, outputting an reversed or non-reversed signal to the linear

10   input signal and having a limiter function of limiting an output signal to predetermined maximum and minimum values; and

        a constant level signal generating circuit for providing the constant level signal to each of the i differential amplifiers, wherein:

15   first, second and third differential amplifiers of the i differential amplifiers are set to have the constant level signals at increasingly higher levels inputted in order, and the output signals of the first and third differential amplifiers and those of the second differential amplifier are

20   set to be of mutually reverse polarity;

        a fourth differential amplifier of the i differential amplifiers has the constant level signal to be inputted set as the signal at the same level as the constant level signal to be inputted to the second differential amplifier, and has

25   the output signal thereof set to be of the same polarity as the output signals of the first and third differential amplifiers and also has a range of the input signal to be the

maximum value and the input signal to be the minimum value set larger than that of the second differential amplifier;

each of (i − 4) differential amplifiers other than the first, second, third and fourth differential amplifiers of the i differential amplifiers has the constant level signal to be inputted set to be either lower than a level of the constant level signal to be inputted to the first differential amplifier or higher than a level of the constant level signal to be inputted to the third differential amplifier, and the output signals of the (i − 4) differential amplifiers and those of the second differential amplifier are set to be of mutually reverse polarity; and

thus constituted to form the output signal of the component of a k-th order function (k is an odd number of 3 or more) on adding up the output signals of the first, second, third and (i − 4) differential amplifiers; and

the fourth differential amplifier is constituted to form the output signal of a linear component for offsetting the linear component of the n-th order function component so as to generate the component of the k-th order function including no linear component by adding the output signals of the i differential amplifiers.

2.   The cubic order component generating circuit according to claim 1, characterized by being set as i = 5 and k = 3.

3.   The cubic order component generating circuit according to claim 2, characterized in that a fifth differential amplifier has the constant level signal to be inputted set to be lower than the level of the constant level signal to

be inputted to the first differential amplifier and also has the range of the input signal to be the maximum value and the input signal to be the minimum value set smaller than that of the first differential amplifier.

5   4.   The cubic order component generating circuit according to claim 2, characterized in that the fifth differential amplifier has the constant level signal to be inputted set to be higher than the level of the constant level signal to be inputted to the third differential amplifier and also has

10   the range of the input signal to be the maximum value and the input signal to be the minimum value set smaller than that of the third differential amplifier.

5.   The fifth order component generating circuit according to claim 1, characterized by being set as i = 6 and k = 5.

15   6.   The fifth order component generating circuit according to claim 5, characterized in that the fifth differential amplifier has the constant level signal to be inputted set to be lower than the level of the constant level signal to be inputted to the first differential amplifier and also has

20   the range of the input signal to be the maximum value and the input signal to be the minimum value set smaller than that of the first differential amplifier, and the sixth differential amplifier has the constant level signal to be inputted set to be higher than the level of the constant level signal to

25   be inputted to the third differential amplifier and also has the range of the input signal to be the maximum value and the input signal to be the minimum value set smaller than that of the third differential amplifier.

7. An m-th order component generating circuit, characterized by comprising:

a plurality j (j is an integer of 4 or more) of differential amplifiers for having a common linear input signal inputted to one input terminal, having a constant level signal of a predetermined level inputted to the other input terminal, outputting an reversed or non-reversed signal to the linear input signal and having a limiter function of limiting an output signal to predetermined maximum and minimum values; and

a constant signal outputting circuit for outputting a constant output signal;

a constant level signal generating circuit for providing the constant level signal to each of the j differential amplifiers, wherein:

first, second, third and fourth differential amplifiers of the j differential amplifiers are set to have the constant level signals at increasingly higher levels inputted in order;

the output signals of the first and second differential amplifiers and those of the third and fourth differential amplifiers are set to be of mutually reverse polarity; and

thus constituted to form the output signal of the component of an m-th order function (m is an even number of 4 or more) on adding up the output signals of the j differential amplifiers; and

the constant signal outputting circuit is constituted to form the output signal of a 0-th order component for offsetting the 0-th order component of the m-th order function component so as to generate the component of the m-th order

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function including no 0-th order component by adding the output
signals of the j differential amplifiers and the constant
signal outputting circuit.

8.   The m-th order component generating circuit according
to claim 7, characterized in that j is an even number of 6
or more, and each of (j - 4) differential amplifiers other
than the first, second, third and fourth differential
amplifiers of the j differential amplifiers has the constant
level signal to be inputted set to be either lower than a level
of the constant level signal to be inputted to the first
differential amplifier or higher than a level of the constant
level signal to be inputted to the fourth differential
amplifier.

9.   The fourth order component generating circuit according
to claim 7, characterized by being set as j = 4 and m = 4.

10.   An approximate n-th order function generating device,
characterized by comprising:

a 0-th order component generating portion for having a
constant signal inputted and generating a constant component;

a linear component generating portion for having a linear
input signal inputted and generating a linear component;

at least one k-th order component generating portion
having a k-th order component (k is an odd number of 3 or more)
generating circuit for having the linear input signal inputted
and a first variable gain amplifying circuit for having an
output signal of the k-th order component generating circuit
inputted;

at least one m-th order component generating portion having an m-th order component (m is an even number of 4 or more) generating circuit for having the linear input signal inputted and a second variable gain amplifying circuit for

5   having an output signal of the m-th order component generating circuit inputted; and

an adding circuit for adding the output signals of the 0-th order component generating portion, the linear component generating portion, the k-th order component generating

10   portion and the m-th order component generating portion, wherein an approximate n-th order function (n is an integer of 4 or more) is generated.

11. An approximate n-th order function generating device, characterized by comprising:

15   a 0-th order component generating portion for having a constant signal inputted and generating a constant component;

a linear component generating portion for having a linear input signal inputted and generating a linear component;

at least one k-th order component generating portion

20   having a k-th order component (k is an odd number of 3 or more) generating circuit according to claim 1 for having the linear input signal inputted and a first variable gain amplifying circuit for having an output signal of the k-th order component generating circuit inputted;

25   at least one m-th order component generating portion having an m-th order component (m is an even number of 4 or more) generating circuit according to claim 7 for having the linear input signal inputted and a second variable gain

amplifying circuit for having an output signal of the m-th order component generating circuit inputted; and

an adding circuit for adding the output signals of the 0-th order component generating portion, the linear component generating portion, the k-th order component generating portion and the m-th order component generating portion, wherein an approximate n-th order function (n is an integer of 4 or more) is generated.

12. An approximate cubic function generating device, characterized by comprising:

a 0-th order component generating portion for having a constant input signal inputted and generating a constant component;

a linear component generating portion for having a linear input signal inputted and generating a linear component;

a cubic component generating portion having a cubic component generating circuit according to either claim 2 or claim 4 for having the linear input signal inputted and a first variable gain amplifying circuit for having an output signal of the cubic component generating circuit inputted;

and

an adding circuit for adding the output signals of the 0-th order component generating portion, the linear component generating portion and the cubic component generating portion.

13. An approximate fourth order function generating device, characterized by comprising:

a 0-th order component generating portion for having a
constant input signal inputted and generating a constant
component;

a linear component generating portion for having a linear
input signal inputted and generating a linear component;

a cubic component generating portion having a cubic
component generating circuit according to either claim 2 or
claim 4 for having the linear input signal inputted and a first
variable gain amplifying circuit for having an output signal
of the cubic component generating circuit inputted;

a fourth order component generating portion having a
fourth order component generating circuit according to claim
9 for having the linear input signal inputted and a second
variable gain amplifying circuit for having an output signal
of the fourth order component generating circuit inputted;
and

an adding circuit for adding the output signals of the
fourth order component generating portion, the cubic component
generating portion, the linear component generating portion
and the 0-th order component generating portion.

14.   An approximate fifth order function generating device,
characterized by comprising:

a 0-th order component generating portion for having a
constant input signal inputted and generating a constant
component;

a linear component generating portion for having a linear
input signal inputted and generating a linear component;

a cubic component generating portion having a cubic component generating circuit according to either claim 2 or claim 4 for having the linear input signal inputted and a first variable gain amplifying circuit for having an output signal of the cubic component generating circuit inputted;

a fourth order component generating portion having a fourth order component generating circuit according to claim 9 for having the linear input signal inputted and a second variable gain amplifying circuit for having an output signal of the fourth order component generating circuit inputted;

a fifth order component generating portion having a fifth order component generating circuit according to claim 5 or 6 for having the linear input signal inputted and a third variable gain amplifying circuit for having an output signal of the fifth order component generating circuit inputted; and

an adding circuit for adding the output signals of the fifth order component generating portion, the fourth order component generating portion, the cubic component generating portion, the linear component generating portion and the 0-th order component generating portion.

15. An approximate n-th order function generating device, characterized by having the linear input signal inputted, outputting an n-th output signal proportional to an n-th order function represented by an n-th order polynomial and including no second order term in the n-th order polynomial.

16. A temperature function generating circuit, characterized by comprising a temperature detecting circuit and the approximate n-th order function generating device according

to claim 15 for having a detection signal of the temperature detecting circuit inputted.

17. A temperature compensation crystal oscillation circuit, characterized by comprising the temperature function generating circuit according to claim 16 and a crystal oscillation circuit for having the approximate n-th order function generated in the temperature function generating circuit inputted.

18. A temperature function generating circuit, characterized by comprising a temperature detecting circuit and the approximate n-th order function generating device according to claim 10 or 11 for having a detection signal of the temperature detecting circuit inputted.

19. A temperature compensation crystal oscillation circuit, characterized by comprising the temperature function generating circuit according to claim 18 and a crystal oscillation circuit for having the approximate n-th order function generated in the temperature function generating circuit inputted.

20. A temperature function generating circuit, characterized by comprising a temperature detecting circuit and the approximate cubic function generating device according to claim 12 for having a detection signal of the temperature detecting circuit inputted.

21. A temperature compensation crystal oscillation circuit, characterized by comprising the temperature function generating circuit according to claim 20 and a crystal oscillation circuit for having the approximate cubic function

generated in the temperature function generating circuit inputted.

22. A temperature function generating circuit, characterized by comprising a temperature detecting circuit and the approximate fourth order function generating device according to claim 13 for having a detection signal of the temperature detecting circuit inputted.

23. A temperature compensation crystal oscillation circuit, characterized by comprising the temperature function generating circuit according to claim 22 and a crystal oscillation circuit for having the approximate fourth order function generated in the temperature function generating circuit inputted.

24. A temperature function generating circuit, characterized by comprising a temperature detecting circuit and the approximate fifth order function generating device according to claim 14 for having a detection signal of the temperature detecting circuit inputted.

25. A temperature compensation crystal oscillation circuit, characterized by comprising the temperature function generating circuit according to claim 24 and a crystal oscillation circuit for having the approximate fifth order function generated in the temperature function generating circuit inputted.

26. A temperature compensation adjustment method, characterized in that, when making a temperature compensation adjustment to a temperature compensation crystal oscillation circuit comprised of a temperature compensation circuit

including a temperature detecting circuit and an approximate n-th order function generating device (n is an integer of 3 or more) and a voltage-controlled crystal oscillation circuit, a measurement is made on an n-th order component VC_{OUTn} to a

5   0-th order component VC_{OUT0} of an output voltage VC_{OUT} of the temperature compensation circuit in a predetermined temperature atmosphere, and measurements are also made, at a plurality of temperatures in a desired temperature compensation range,· on an input voltage VC_{IN} at which an

10   oscillating frequency outputted from the voltage-controlled crystal oscillation circuit matches a preset selected frequency, and the n-th order component VC_{OUTn} of the output voltage VC_{OUT} measured at each temperature is approximated as a function of a temperature T by:

15        $VC_{OUTn}'(T) = VC_{OUTn}(T) - VC_{OUT0}(T)$,

and the output voltage VC_{OUT} is described as a function of the temperature T by:

$VC_{OUT}(T) = \alpha_n VC_{OUTn}'(T + \Delta T) + \ldots\ldots$

$+ \alpha_3 VC_{OUT3}'(T + \Delta T) + \alpha_1 VC_{OUT1}'(T + \Delta T)$

20    $+ VC_{OUT0}'(T + \Delta T) + \alpha_0$,

and coefficients α_n to α_3, α_1, α_0 and ΔT of the temperature compensation circuit are adjusted so that the input voltage VC_{IN} and the output voltage VC_{OUT} measured at each of the temperatures are matching.

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